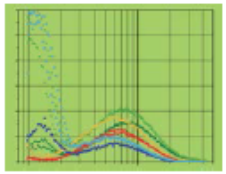
Berner Fachhochschule
Haute école spécialisée bernoise
Bern University of Applied Sciences



ETH-NPC-Verein
c/o Thomas Lutz
Aktuar
Brunnenwiese 53
CH-8132 Egg bei Zürich

AFHB

University of Applied Sciences
Biel-Bienne, Switzerland
IC-Engines and Exhaust Gas Control

Targets and Achievements of the ETH Nanoparticle Conferences 1997 - 2016

Jan Czerwinski
Laboratories for IC-Engines and
Exhaust Emission Control, Biel, CH

20th NPC ETHZ, June 14th, 2016

Principal Targets of NPC

Promoting the knowledge exchange about:

NP …

- analytics,
- emissions from different sources,
- reduction measures,
- basic research,
- health effects,
- legal activities

Support of young researchers, easy participation free of charge, new ideas.

The higher motivation is:

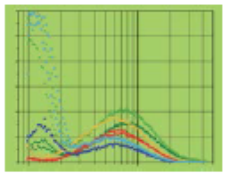
Health & Environment Protection

University of Applied Sciences
Biel-Bienne, Switzerland
IC-Engines and Exhaust Gas Control

TTM

Some Statistics and History 1997 – 2015

Mr. A. Mayer
Mr. Th. Lutz
Mrs. K. Frenkel
Mrs. A. Anselmi



ETH-NPC-Verein
c/o Thomas Lutz
Aktuar
Brunnenwiese 53
CH-8132 Egg bei Zürich

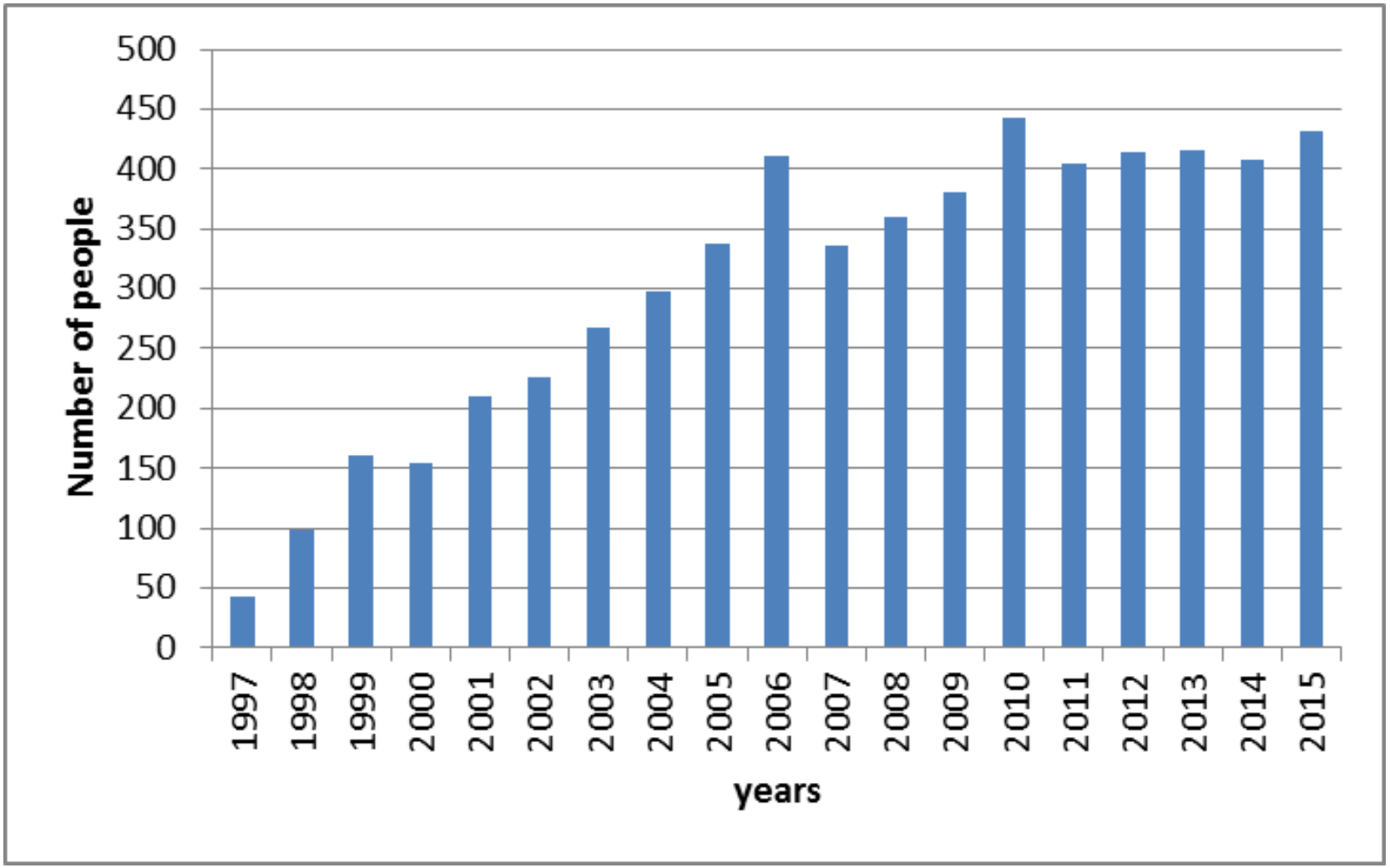
Developing the name of the Conference

1997 – 1999
International ETH-Workshop on "Nanoparticle Measurement"

2000 – 2002
International ETH-Conference on "Nanoparticle Measurement"

2003 – 2016
ETH Conference on "Combustion Generated Nanoparticles"

Registrations



Registrations and participation (Theory and Practice)

		2015	2014	2013	2012	2011	2010
Conference	registration	434	408	430	417	404	441
	participation	365	346	365	397	370	340
Welcome party	registration	236	200	181	150	128	178
	participation	110	100	90	90	80	100
Galla Dinner	registration	274	244	255	247	216	220
	participation	210	205	220	235	190	200

International Participation (19th Conference 2015)

Participants from 31 countries

44.0%	Switzerland
18.5%	Germany
6.5%	USA
2.0 – 2.8%	England, Finland, Italy,
	Austria, Poland, Japan, Sud-Korea
	(9-12 participants)

Contributions and Frequent Speakers

1997 to 2015

746 Authors

1604 Contributions

- 982 papers
- 622 posters

Frequent Speakers

Prof. David Kittelson, University of Minnesota	20 papers
Dr. Athanasios Konstandopoulos, CERTH/CPERI	18 papers
Dr. Imad Khalek, SWRI	14 papers
Porf. Mridul Gautam, West Virginia University	13 papers

Context of Activities about NP-Emissions in Switzerland

1993/1994 Suva AUVA TBG

1994-1998 Project VERT

DPF most efficient in underground

1997 1st NPC


– PCCI or PCI (
– RCCI (Reactio
– All rely on co
of soot and N
to completely
• There are also fu
– Natural gas
– DME (dimeth
– Hydrogen
• But all of these
range
• The work prese
ethanol, gasoli
• Number and m
contemporary
all volatile


ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

University of Applied Sciences
Biel-Bienne, Switzerland
IC-Engines and Exhaust Gas Control

Context of Activities about NP-Emissions in Switzerland

1993/1994 Suva AUVA TBG

1994-1998 Project VERT

DPF most efficient in underground

1997 1st NPC

2002 DPF for all construction sites in CH

1998-2008 AKPF – Working Group
for DPF – Technology → AKPF Workshops

2007 SNR 277 205 since 2010 SN 277 206

Since 2009 OAPC (Ordinance on Air Pollution Control)
VERT Association (international BAT – activities)
VERT Forum (End of March)

Context of Activities about NP-Emissions in Switzerland

1993/1994 Suva AUVA TBG

1994-1998 Project VERT

DPF most efficient in underground

1997 1st NPC

2002 DPF for all construction sites in CH

1998-2008 AKPF – Working Group
for DPF – Technology → AKPF Workshops

2007 SNR 277 205 since 2010 SN 277 206

Since 2009 OAPC (Ordinance on Air Pollution Control)
VERT Association (international BAT – activities)
VERT Forum (End of March)

2010-2014 BAFU – JRC Memorandum of Understanding


Lee Jeans

University of Applied Sciences
Biel-Bienne, Switzerland
IC-Engines and Exhaust Gas Control

Context of Activities about NP-Emissions in Switzerland

1993/1994 Suva AUVA TBG

1994-1998 Project VERT

DPF most efficient in underground

1997 1st NPC



2002 DPF for all construction sites in CH

1998-2008 AKPF – Working Group
for DPF – Technology → AKPF Workshops

2007 SNR 277 205 since 2010 SN 277 206

Since 2009 OAPC (Ordinance on Air Pollution Control)
VERT Association (international BAT – activities)
VERT Forum (End of March)

2010-2014 BAFU – JRC Memorandum of Understanding

2001 Swiss Contribution to PMP (BUWAL, TTM, Matter, AFHB)

Since 2001 Swiss participation on GRPE, PMP and REC

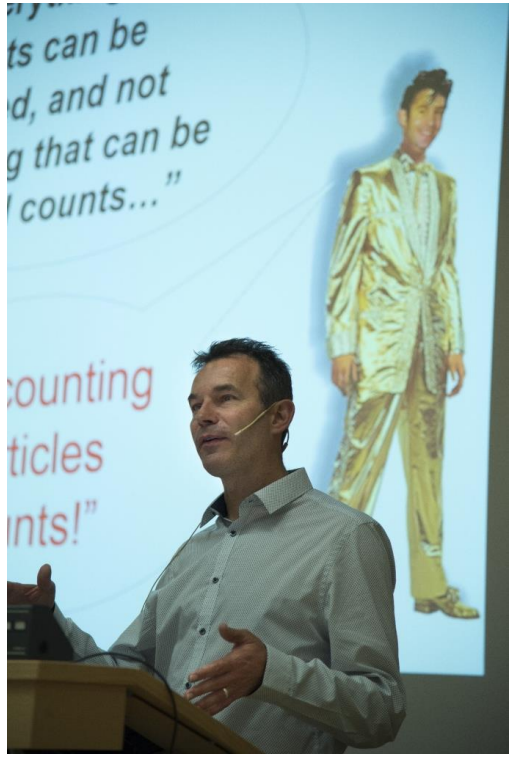


2014 (March 2014) NPC Association

What Happend Internationaly about NP

2000	Peugeot FAP 1st DPF from OEM
Since Nov. 2000	PMP (GRPE)
2007	EU: 1st PMP guideline about legal PN-measurement

2009	Euro 5a Diesel passenger cars 6 x 10^{11} # / km
2012	WHO / IARC declare Diesel exhaust as "carcinogenic to humans (group 1)"
2013	Euro VI HD vehciles (Diesel) 6 x 10^{11} # / km
2014	Euro 6b SI passenger cars (DI) 6 x 10^{12} # / km
2015	REC
2016	NRMM guideline NP-limits



NP
became a recognized
emission component

Evolution of the contents

Sessions topics

Start in 1997: NP-emission sources, ambient, measurements
engines, basics

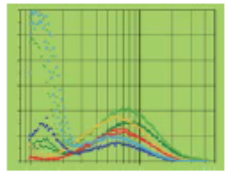
1999 : 1st small "Health session"

since 2003 two "Health sessions" :
(7th conference)

Other continuous topics:

- International projects (2000), regulatory (2004), legislation (2007)
- Instrumentation, sampling, calibration
- Ambient, climate, workplace
- IC-engines emissions
- Aftertreatment, DPF
- Other emission sources
- Basic investigations and fundamentals

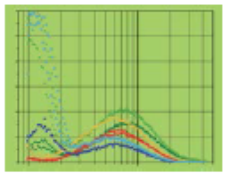
Since 2006 Focus-Events
(10th Conference)



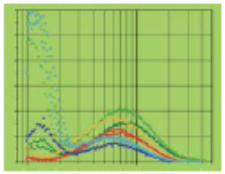
ETH-NPC-Verein
c/o Thomas Lutz
Aktuar
Brunnenwiese 53
CH-8132 Egg bei Zürich

Institut für Energietechnik
LAV
Laboratorium für Aerothermochemie und Verbrennungssysteme
ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich
n|w Fachhochschule Nordwestschweiz
University of Applied Sciences
Biel-Bienne, Switzerland
IC-Engines and Exhaust Gas Control

Some interesting peak points



ETH-NPC-Verein
c/o Thomas Lutz
Aktuar
Brunnenwiese 53
CH-8132 Egg bei Zürich



ETH-NPC-Verein
c/o Thomas Lutz
Aktuar
Brunnenwiese 53
CH-8132 Egg bei Zürich

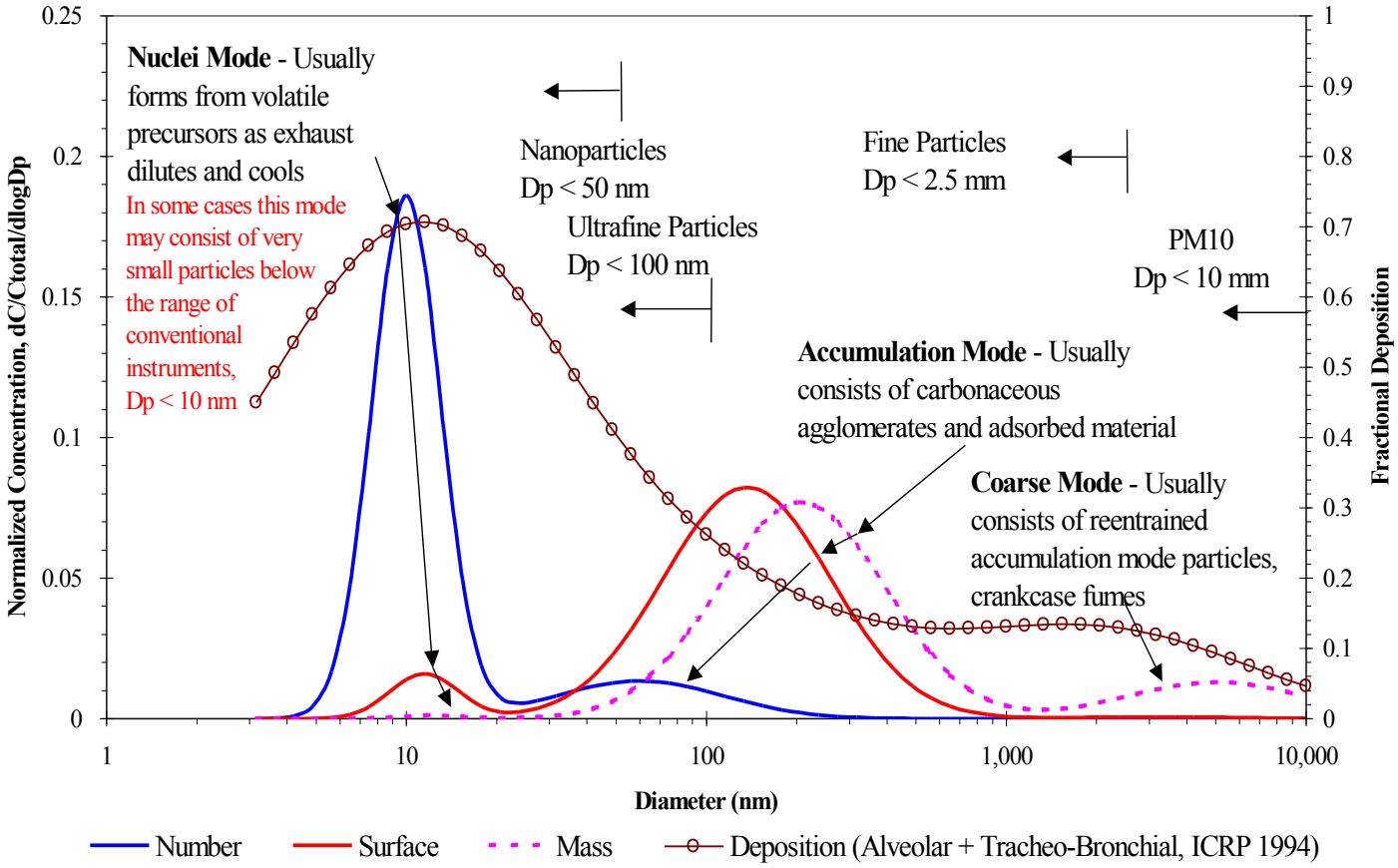
University of Applied Sciences
Biel-Bienne, Switzerland
IC-Engines and Exhaust Gas Control

PN

UFP

Nanoparticles

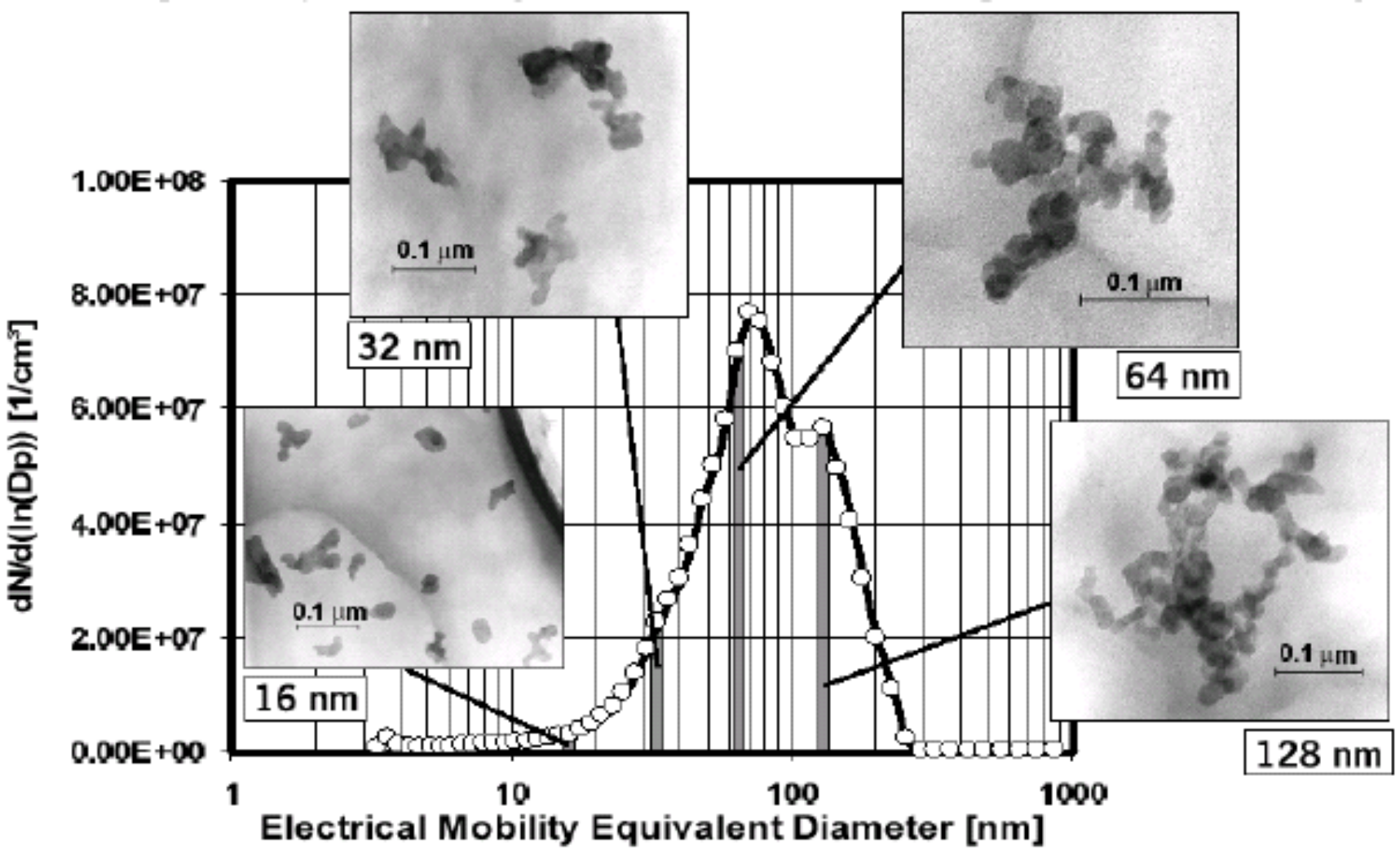
Typical Diesel Particulate Size Distribution



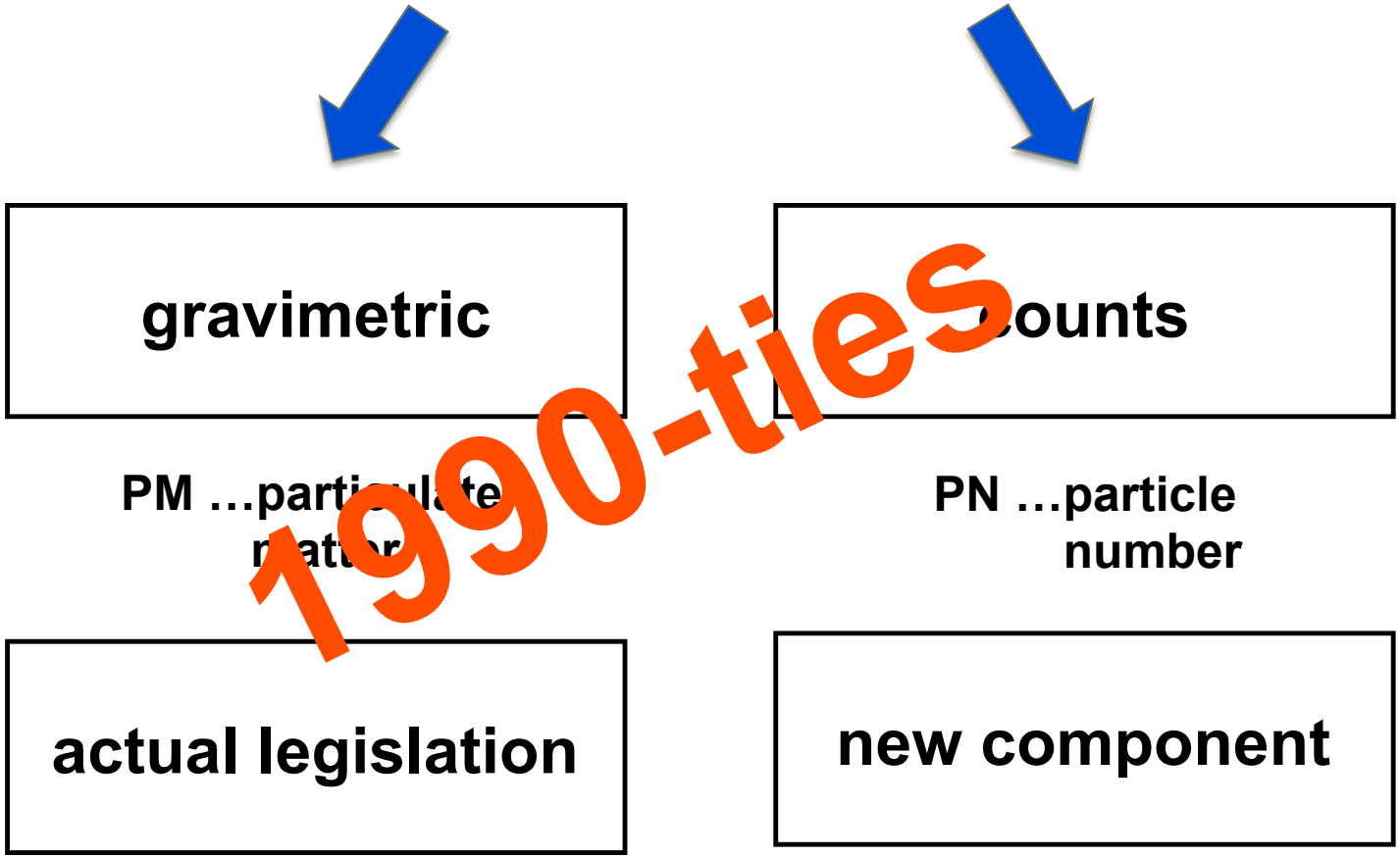
[D. Kittelson]

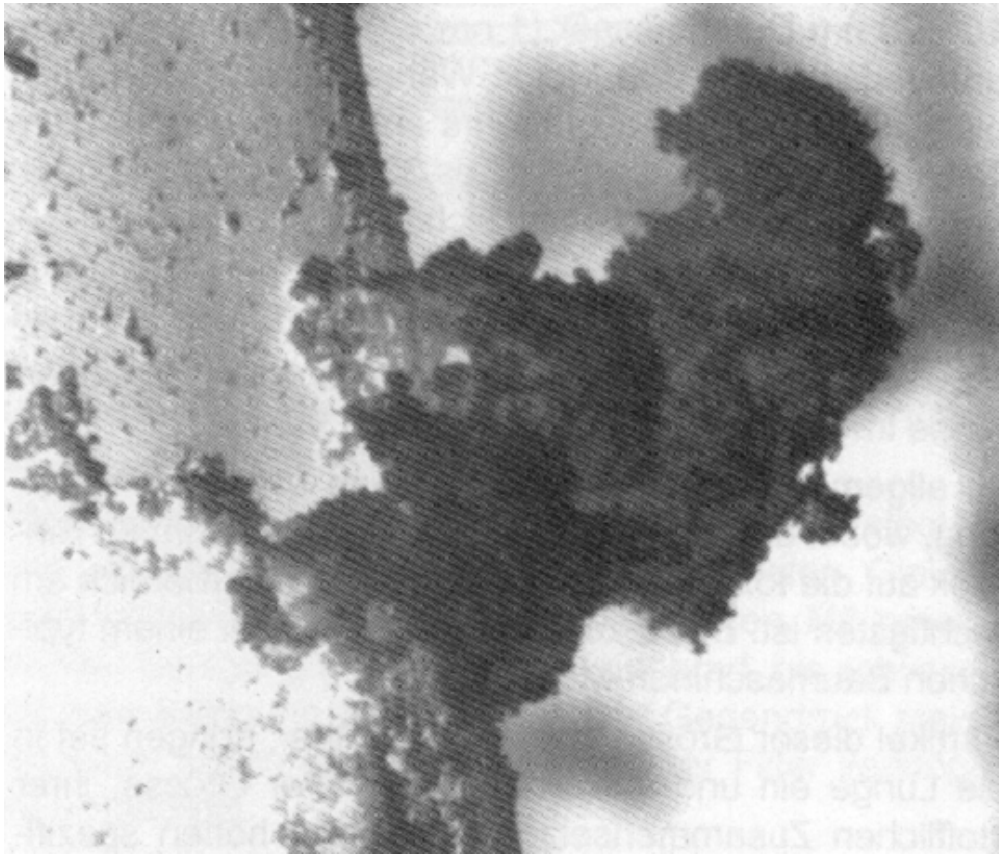
University of Applied Sciences
Biel-Bienne, Switzerland
IC-Engines and Exhaust Gas Control

Morphology of Nanoparticles



Emissions of solid particles from Diesel engines





Soot deposition on a 10 µm filter fiber;
a large agglomerate, formed on the fiber and
many ultrafine particles in the size range of 100 nm

$(PN)_{max}$

Diesel:

$10^6 - 10^7 \left[\frac{1}{cm^3}\right]$

Ambient air:

$\sim 2{,}5 \times 10^4 \left[\frac{1}{cm^3}\right]$

$\sim 2{,}5 \times 10^{13}$ Molecules

[A. Mayer]

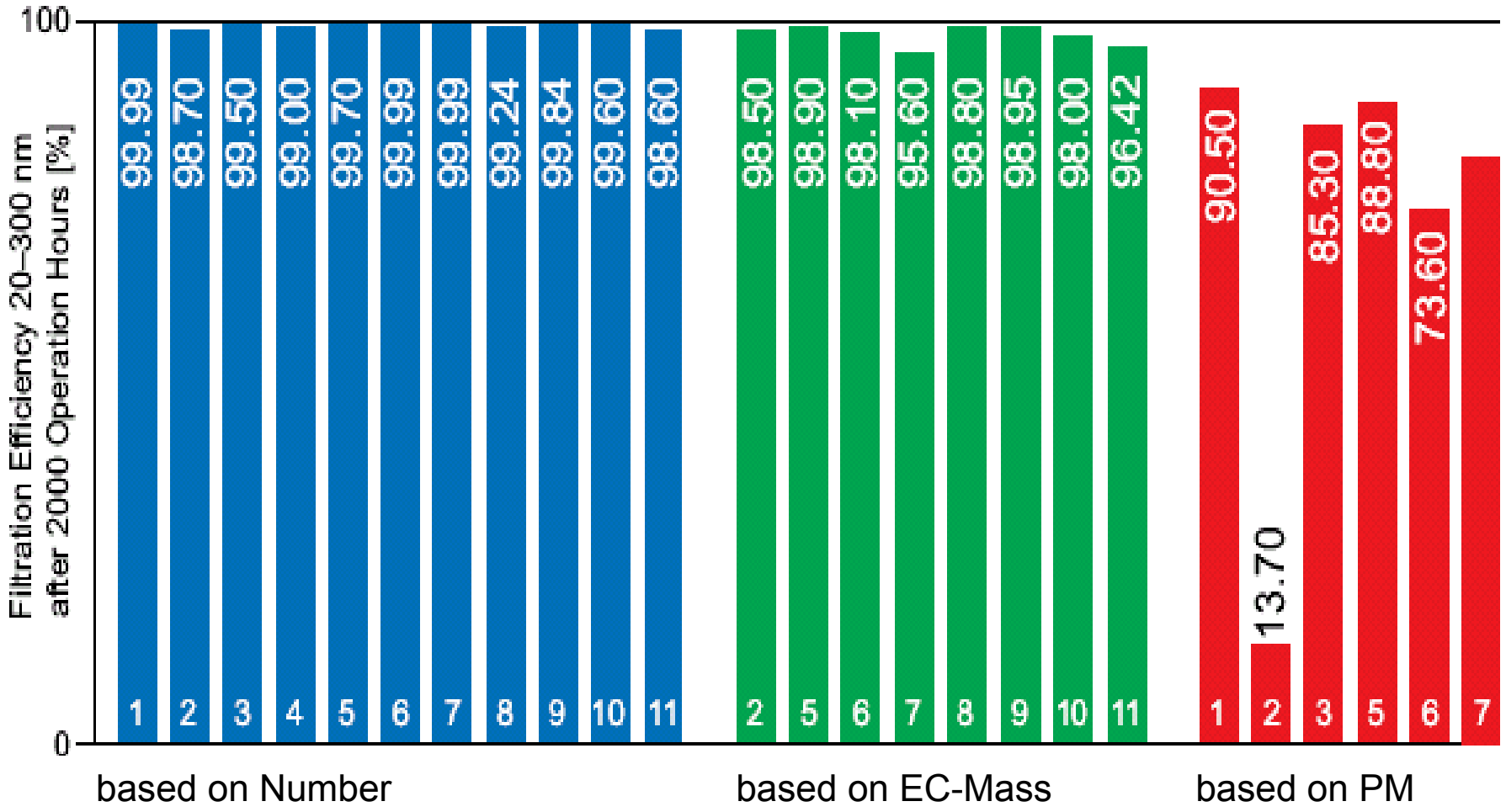
University of Applied Sciences
Biel-Bienne, Switzerland
IC-Engines and Exhaust Gas Control

DPF

TTM

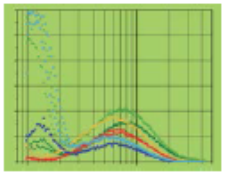
AFHB

University of Applied Sciences
Biel-Bienne, Switzerland
IC-Engines and Exhaust Gas Control



VERT Particle Filter-Verification (all Systems after 1998)

ISO 8178 Test-Cycle. Number by TD+SMPS+CPC. EC-Mass by Coulometry. PM as usual.

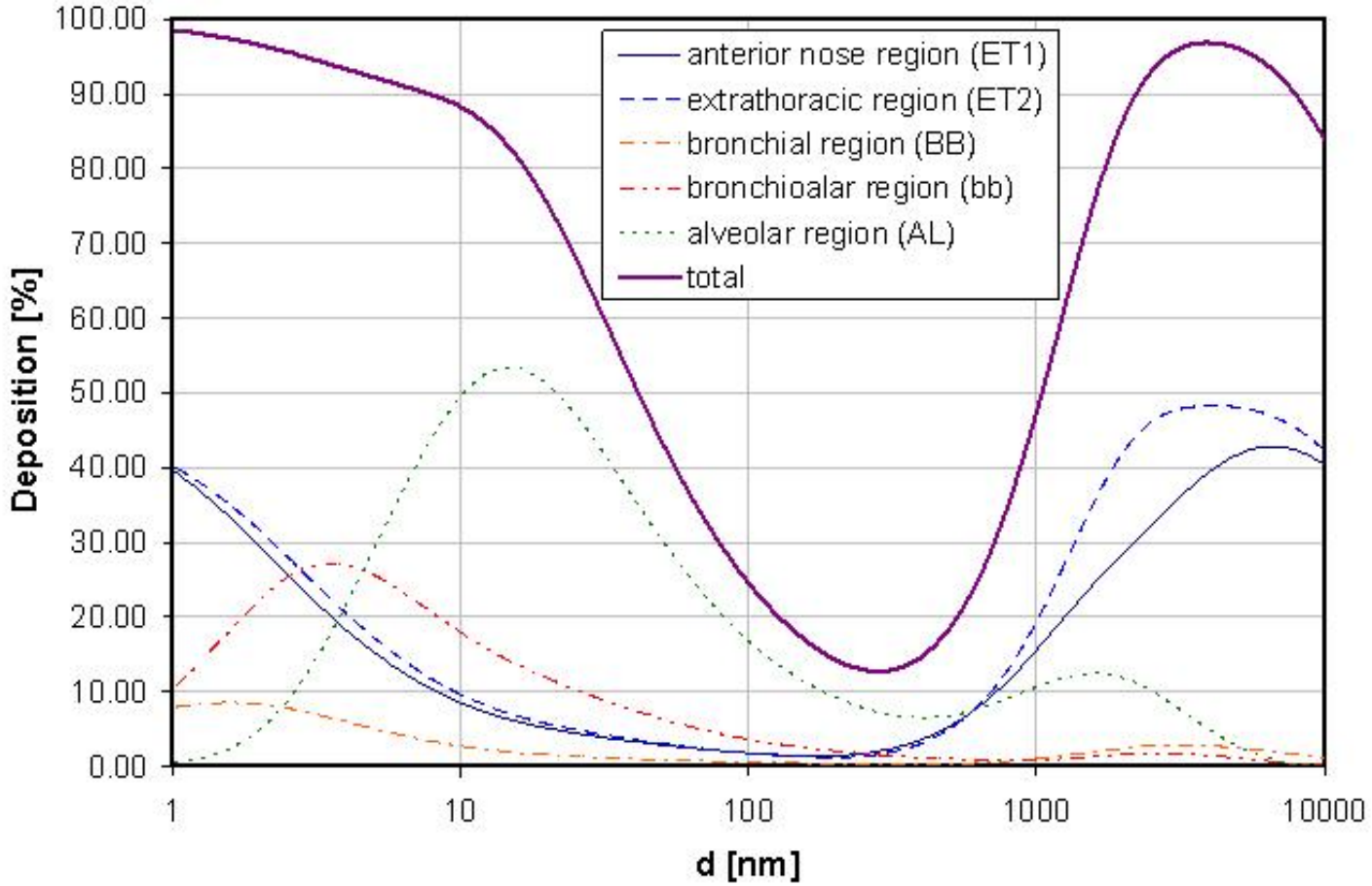


ETH-NPC-Verein
c/o Thomas Lutz
Aktuar
Brunnenwiese 53
CH-8132 Egg bei Zürich

University of Applied Sciences
Biel-Bienne, Switzerland
IC-Engines and Exhaust Gas Control

Health Effects

Inhalation Deposition of Particles (Morrow et al, 1964)z



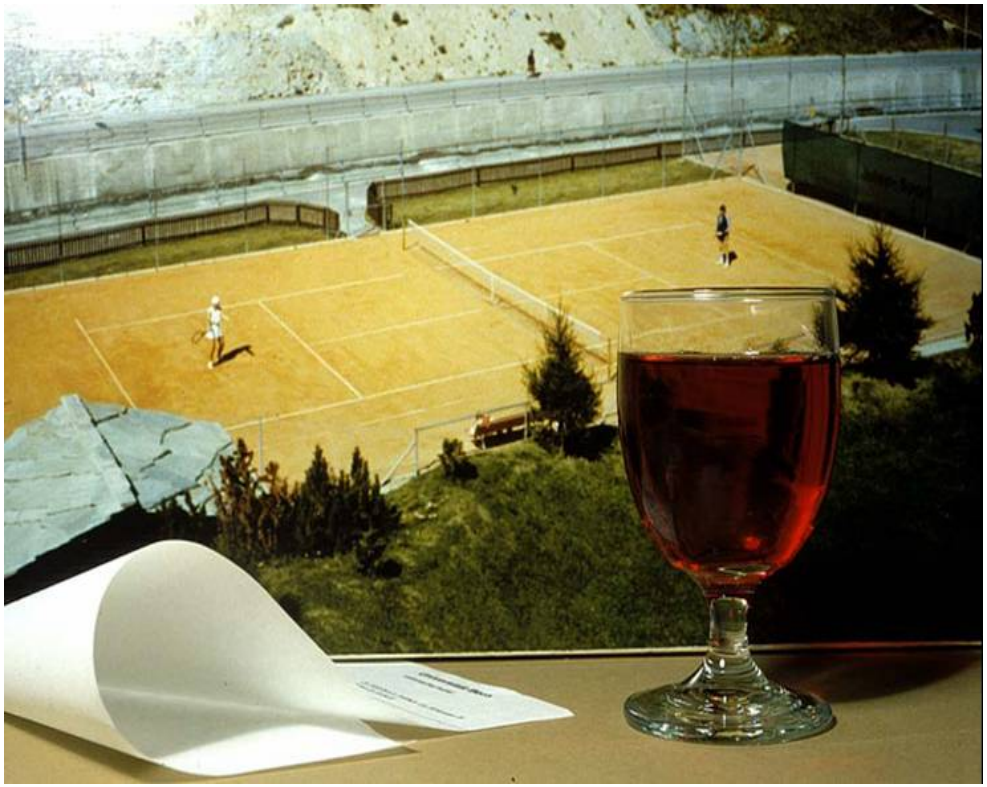
Stereological estimation of the size of the gas exchange apparatus:

Lungs:

• Gas exchange region:	80-90%
• Airways:	5-10%
• Blood vessels:	5-10%

Gas exchange region:

• Gas exchange region:	80-90%
• Alveoli	300 millions, diameter ¼ mm
• Fraction of air:	80-90%
• **Gas exchange surface area:**	140 m^2 ***tennis field***
• **Capillary volume:**	210 cm^3 ***red wine glass***
• **Air-blood barrier:**	2 µm ***1/50 thickness airmail paper***



Prof. P. Gehr

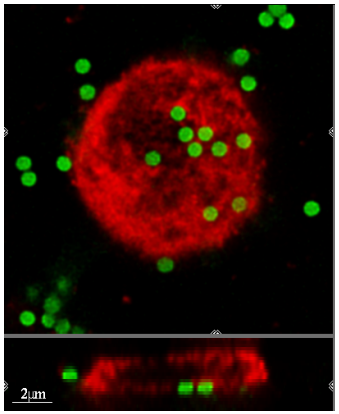
University of Applied Sciences
Biel-Bienne, Switzerland
IC-Engines and Exhaust Gas Control

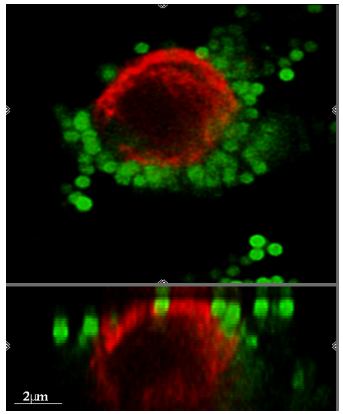
Macrophages *in vitro*: Laser Scanning Microscopy

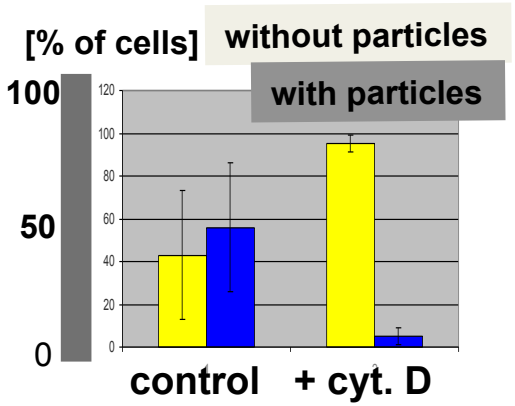
control + cytochalasin D

F-Actin

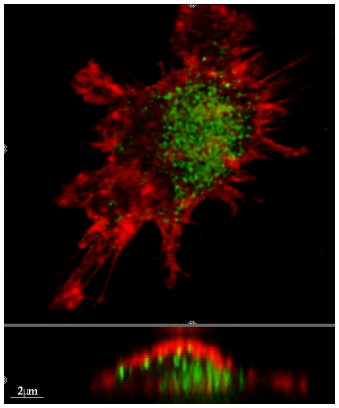
1-mm polystyrene particles

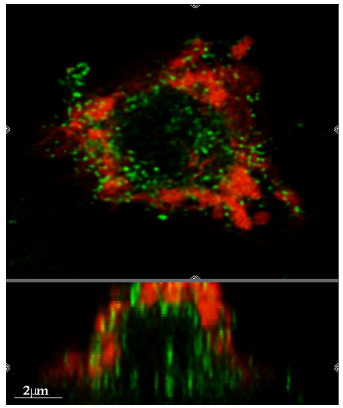


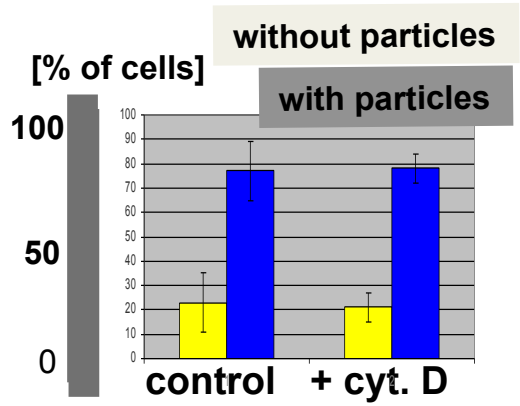




78-nm polystyrene particles







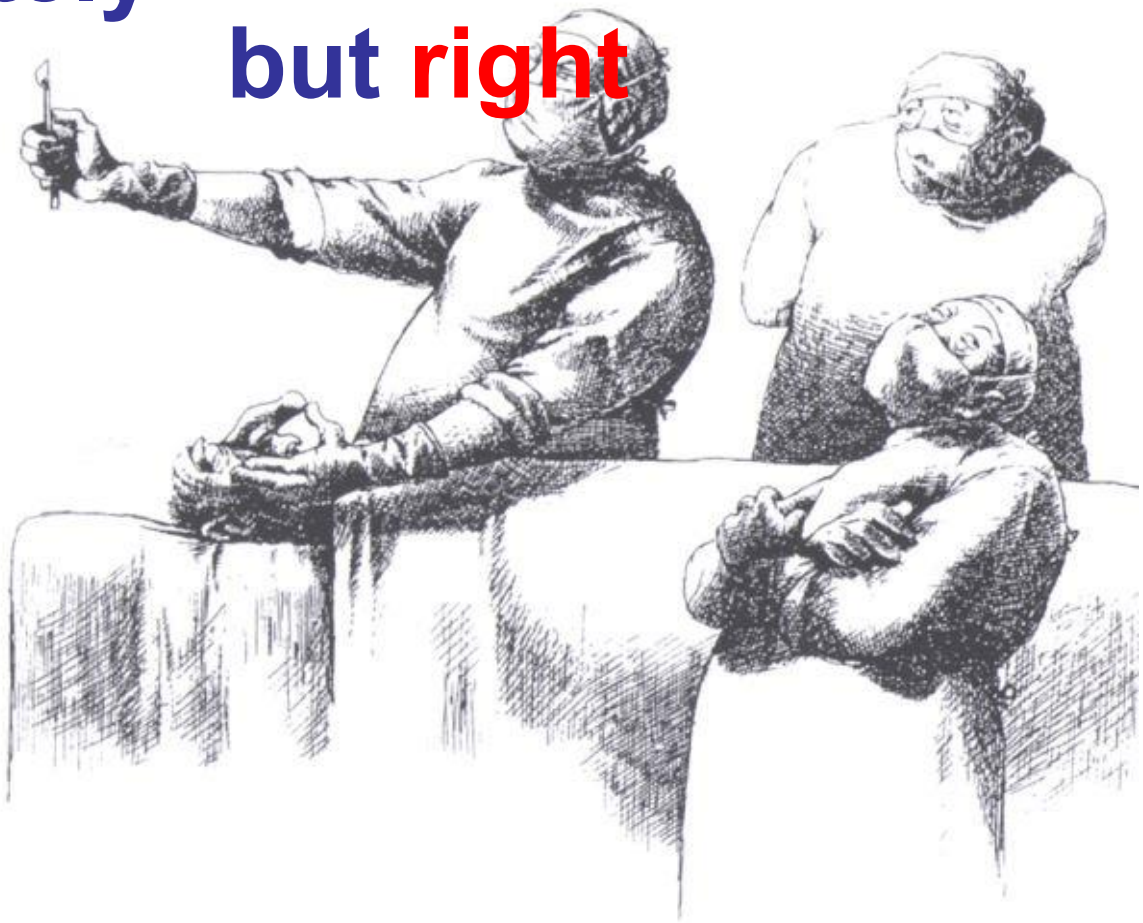
B. Rothen-Rutishauser
In: Geiser et al., EHP
(in press)

Better

approximately

than

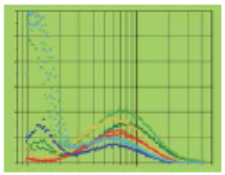
but right



exactly

but

wrong

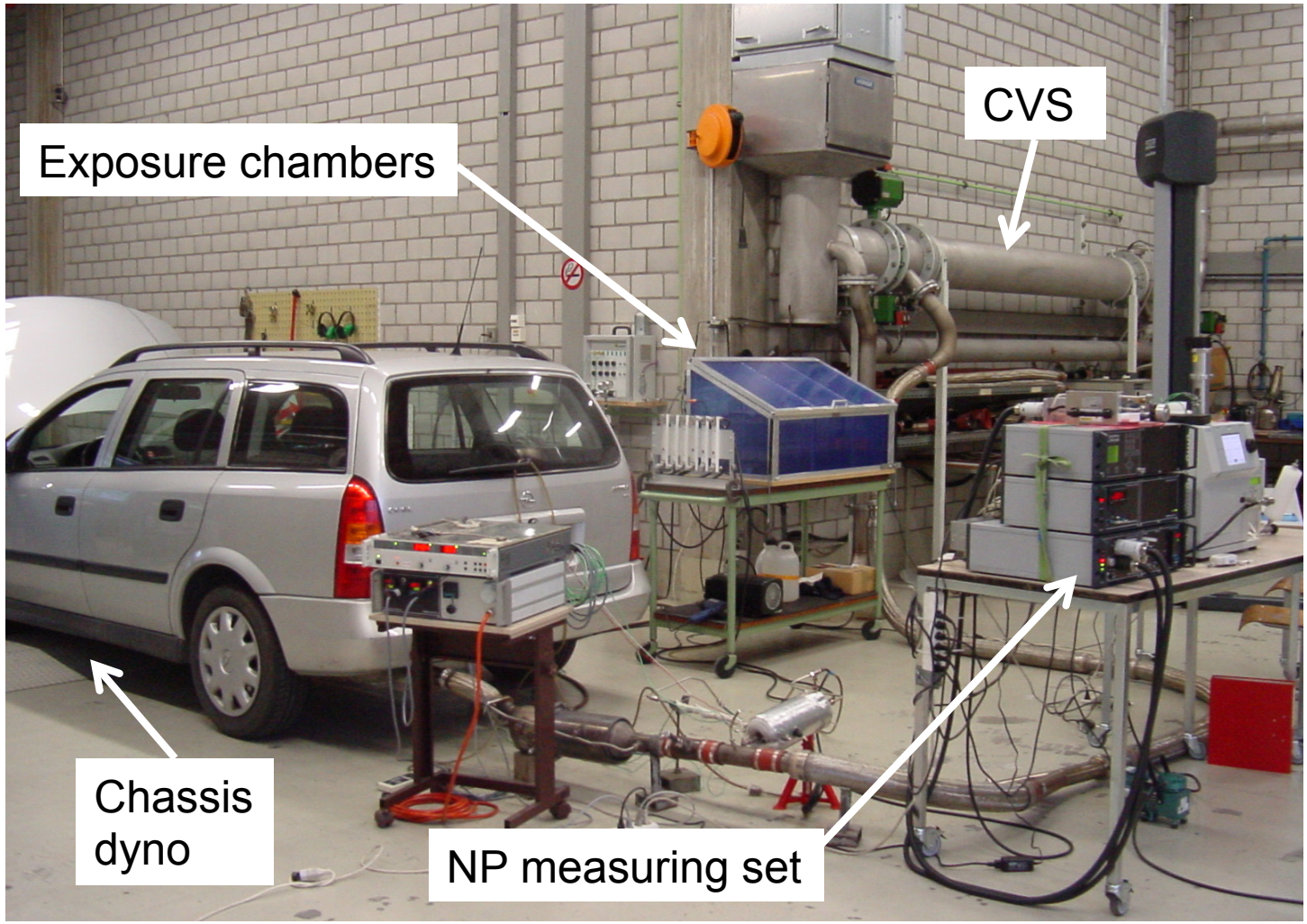


ETH-NPC-Verein
c/o Thomas Lutz
Aktuar
Brunnenwiese 53
CH-8132 Egg bei Zürich

University of Applied Sciences
Biel-Bienne, Switzerland
IC-Engines and Exhaust Gas Control

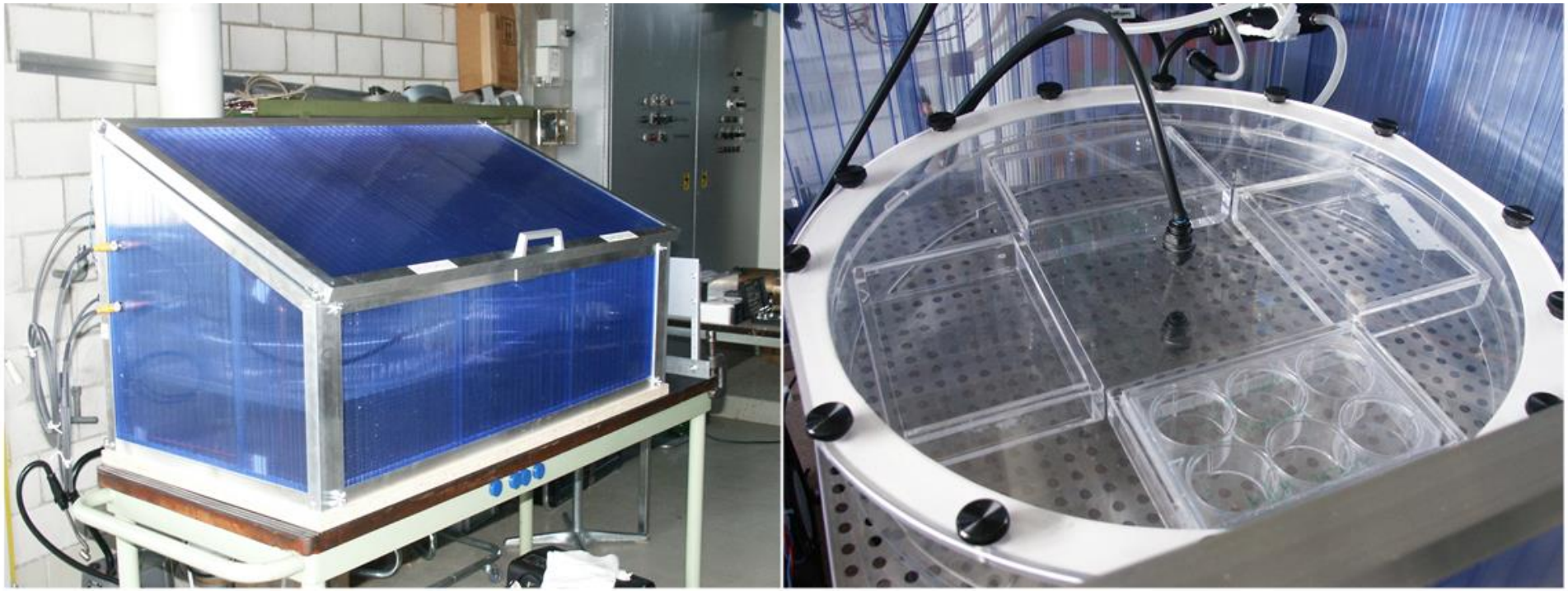
Interdisciplinary Research of Engines Toxicity

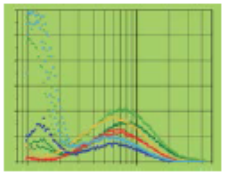
Exposure tests on a Diesel passenger car



Exposure system (left image) and exposure chamber (right image)

[A. Konstandopoulos, J.-P. Morin]



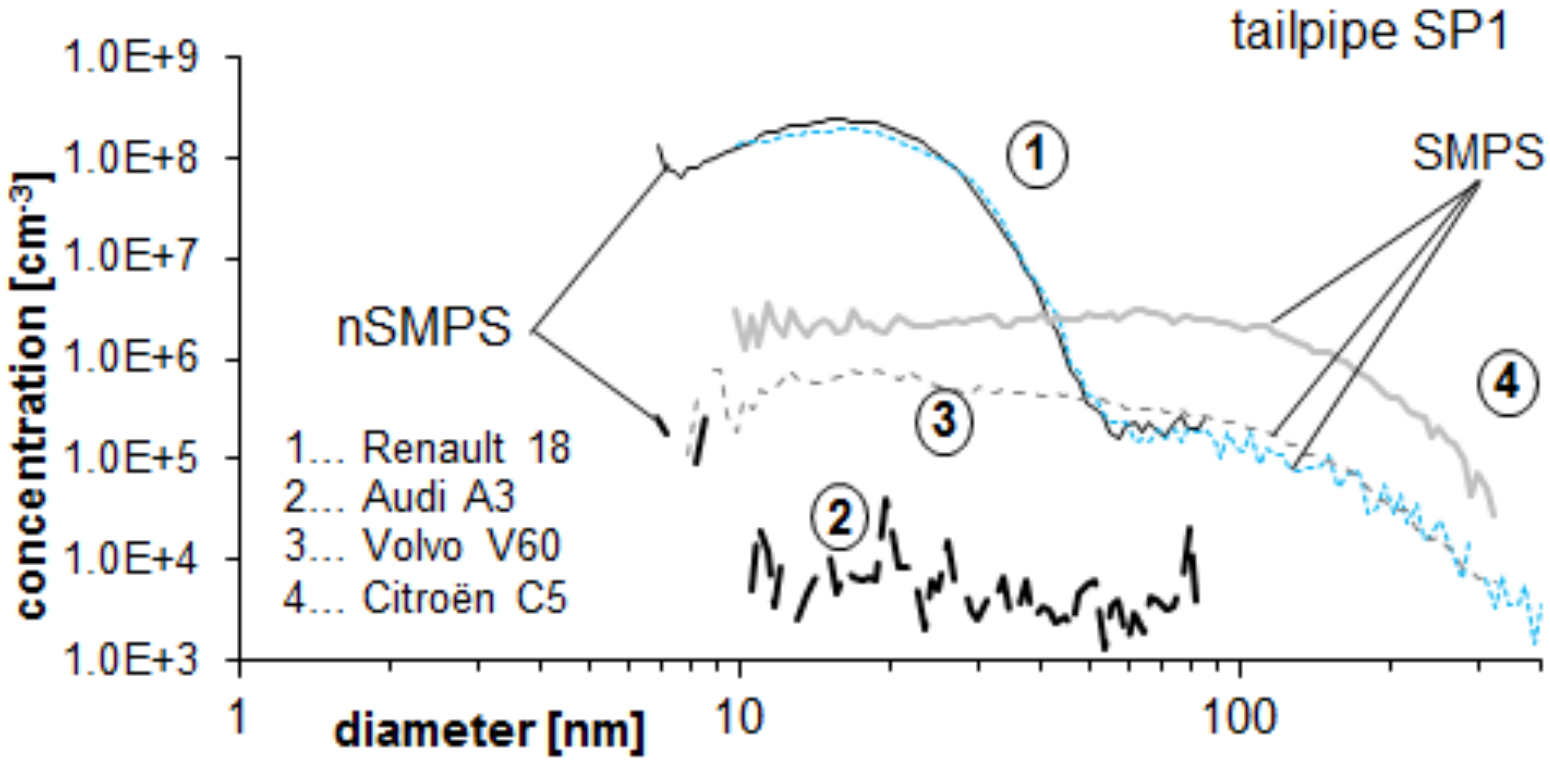


ETH-NPC-Verein
c/o Thomas Lutz
Aktuar
Brunnenwiese 53
CH-8132 Egg bei Zürich

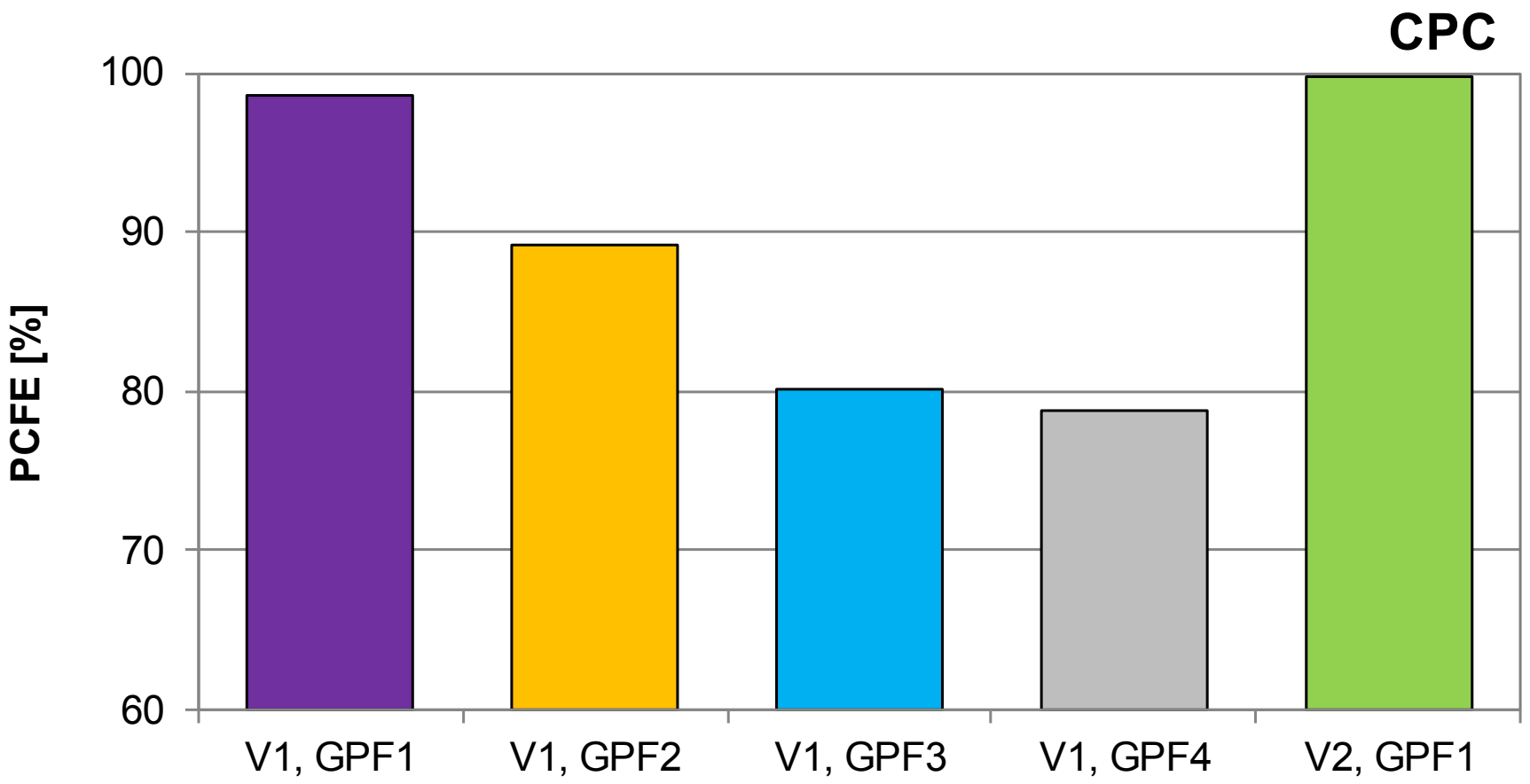
University of Applied Sciences
Biel-Bienne, Switzerland
IC-Engines and Exhaust Gas Control

GDI & GPF

Particle size distributions of different vehicles at tailpipe & 40 km/h

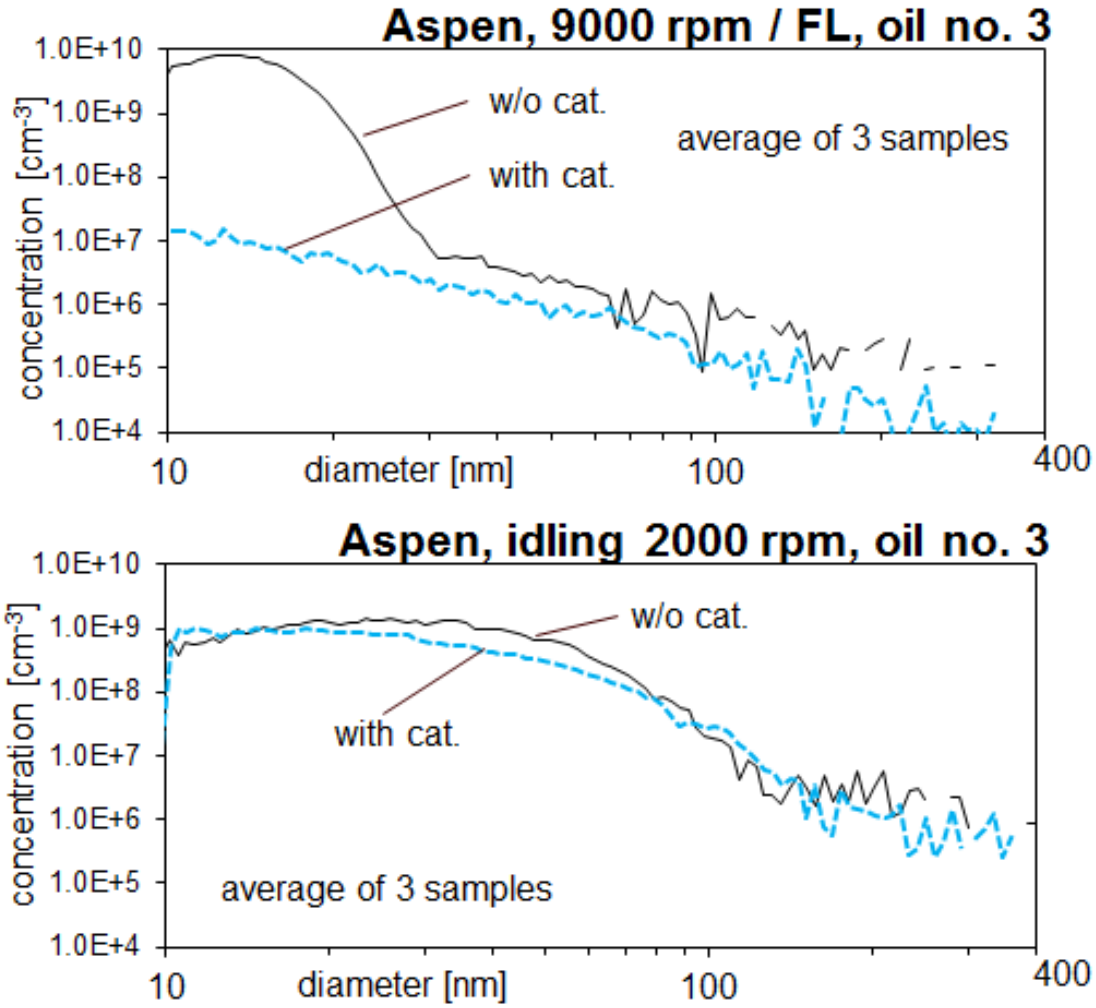


PCFE's of the investigated GPF's in WLTC hot



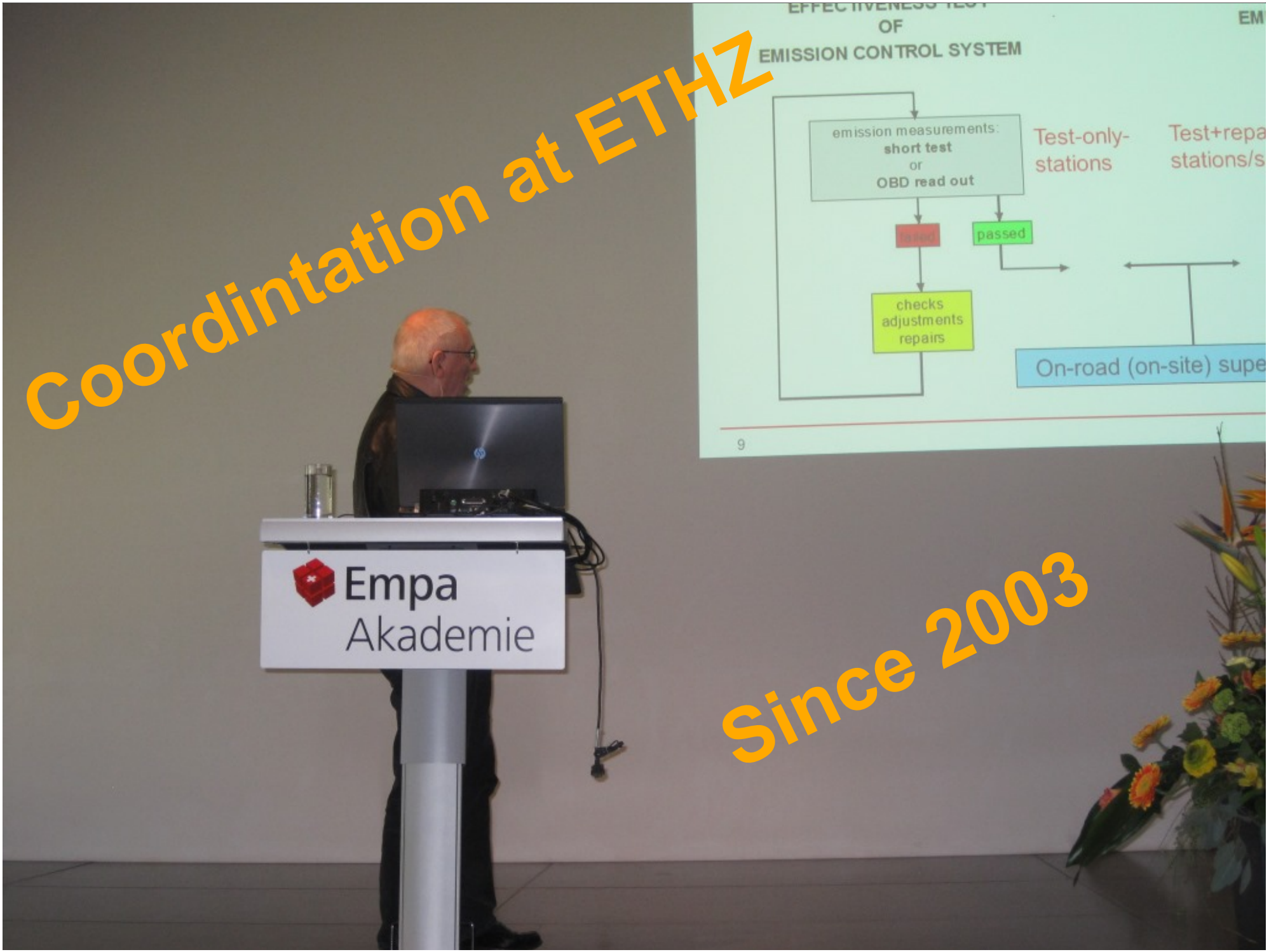

Handheld Machines

Influences of oxidation catalyst on particle size distributions (PSD) at full load & idling



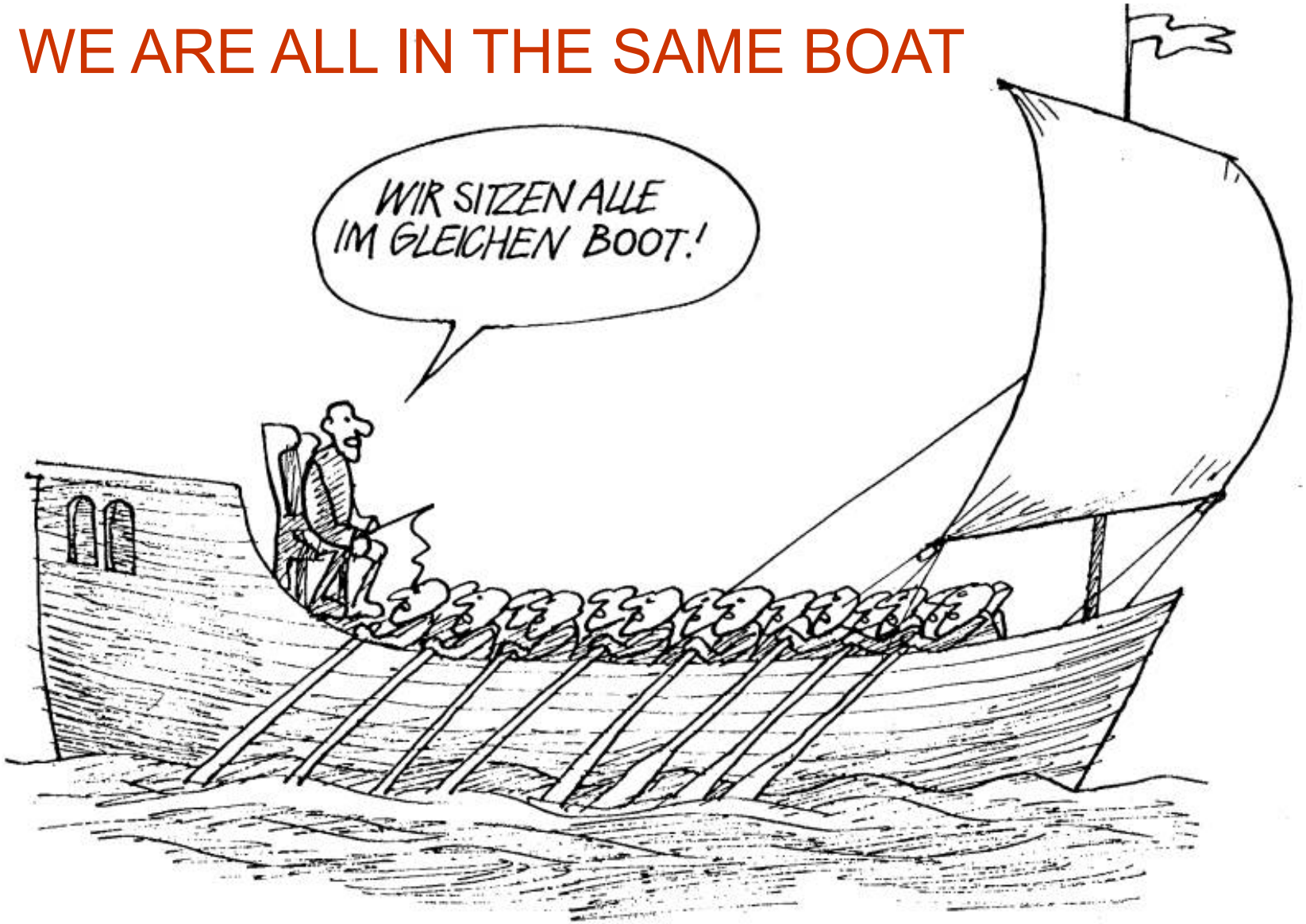
Achievements

- Knowledge transfer, studies and repetitions
- New generations of researchers and scientists
- Special merits in health effects research
- National and international impacts
- Networking and inspirations


Coordintation at ETHZ
Since 2003
OF
EMISSION CONTROL SYSTEM
emission measurements:
short test
or
OBD read out
Test-only-
stations
passed
checks
adjustments
repairs
On-road (on-site) supe
9
Empa
Akademie


Working with
DPF since 1983
Dom / Stadthaus

WE ARE ALL IN THE SAME BOAT




Thanks to
the Organization Committee
and to you
Ladies and Gentlemen